Changes in Biological Doctrines During the Past Twenty-five Years.

BY

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OF NEW YORK.

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ANNUAL ADDRESS

BEFORE THE

ALUMNI ASSOCIATION OF JEFFERSON MEDICAL COLLEGE OF PHILADELPHIA.

BY

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CHANGES IN BIOLOGICAL DOCTRINES DURING THE PAST TWENTY-FIVE YEARS.

Mr. President and Fellow Alumni—Accept my cordial greetings! Ladies and gentlemen who are honoring us with your presence, you are all heartily welcome!

Gentlemen of the Graduating Class of 1882: All of the preliminary severe ordeals, though not all of the ceremonies, connected with your entering upon your *life-work* are past! We have come together to congratulate you on your union with the medical profession, to receive you into our alumni-brotherhood, to extend to you a friendly hand as you step across the barrier that separates your days of mere learning from those of practicing as well as learning!

Dr. Richard O. Cowling, of Louisville, Kentucky, had originally been elected to be our Orator; but, alas, his eloquent voice was hushed in death within a month of his election.

Gentlemen, I come before you as a member of the Class of 1857, a Class that on this occasion celebrates its silver wedding with the profession. Just as our beloved Alma Mater, "Dear old Jeff," sends you out, a strong detachment—strong in knowledge, strong in ability, and strong in enthusiasm—to wage battle against disease and death, so she sent our class out, a company of 212, twenty-five years ago.

When we entered the College its teaching was conducted by the still unbroken phalanx of the magnificent Faculty of 1841, consisting of Robley Dunglison, Dean, the encyclopædic well of the Institutes of Medicine; Robert M. Huston, the conscientious, clear and solid lecturer on Materia Medica; Joseph Pancoast, the honored and famous anatomist as well as clinical operator; John K. Mitchell, the popular and distinguished teacher of Practice; Charles D. Meigs, the brilliant, never-to-be-forgotten, obstetrician and gynecologist; Franklin Bache, the accurate and learned professor of chemistry; and Thomas D. Mütter, the able and charming surgeon.

I use these insufficient epithets simply to indicate the *Chair* held by each of the members of this renowned Faculty. As an earnest and harmonious corps of excellent teachers, they have never been surpassed; as has been said in a former address before this Association, "they were men of mark. Some were great men; all were great professors."

Our *Alma Mater* is in mourning; for the last survivor of this Faculty, Joseph Pancoast, has just passed away: *Semper honos nomenque tuum laudesque manebunt!*

It was during our pupilage that the resignation, on account of ill health, of Dr. Mütter made the first break in the ranks of this veteran corps; and our Class was the first who received the benefit of the instruction, and whose diplomas bear the name, of that illustrious Alumnus of "old Jeff" of more than fifty years' standing, who is the President of this Association, and who was its first Orator, Samuel D. Gross.

At our graduation Professor Mitchell delivered a "Charge" to us which I wish each of you present here this evening could have heard. No better rule for action could be given to young physician or old. The duties and responsibilities of professional life were solemnly impressed upon us; its highest and noblest aims, with incentives and counsels as to the best means for their attainment, were eloquently discoursed upon; and we were bidden to go forth "with clear heads, strong hands and stout hearts," "emulous for the public good." Our beloved preceptor wished us "every safe honor, every reasonable blessing; knowledge for every difficulty, decision for every emergency, patience for every trial, and triumph for every conflict."

If I were to indulge myself in speaking of the *personnel* of the Class individually, I should certainly transcend the time allotted me; but I cannot help remarking, with pride, that our class-list contains names that have become conspicuous in medical records; names such as Robert Battey, the ovariotomist; Austin Flint, Jr., the physiologist; Samuel W. Gross, the surgeon; nor can I help adding, with sadness, that the list of the living, out of the 212, has greatly dwindled down during the interval of

twenty-five years, for, as Shakspeare has it, although—

"By medicine life may be prolonged,
Yet death will seize the doctor too."

Since our graduation, valuable discoveries and improvements have been made in every department of medicine and surgery. The advances have been so great, so rapid, and so manifold, that no man could possibly succeed in making himself acquainted with them all in detail. Let me give you, as an example, the case of an improvement in the healing art that I am especially familiar with. During the very next year after graduating I was present, in Vienna, Austria, at the birth of a new, and really very simple, method of exploration—laryngoscopy—the introduction of which has determined the direction of my own professional life. Laryngoscopy is the method of inspecting, by means of a mirror, the larynx and adjacent parts. In rendering accessible to our view, in living, working order, organs before veiled from mortal eyes, laryngoscopy has, in many different respects, promoted the cause of human investigation. To the enquirer in the fields of general science, of physiology, of oratory, and of vocal music, it has not only directly revealed an innumerable array of facts, but has opened sources of information previously unthought of. As an aid in diagnosis, to the physician, it has completely revolutionized laryngo-pathology. Previously, the diagnosis of laryngeal diseases was vague and unsatisfactory; it was necessarily based upon symptoms by no means differentially pathognomonic; symptoms often confusing by their uniformity under dissimilar circumstances, and occasional presence or absence in apparently the same affections; so that, to admit the truth in plain words, personal, shrewd ratiocination and guessing, instead of positive data, were too frequently its only foundation, and, as not inaptly expressed, the recognition of an individual laryngeal disease was but "a happy knack acquired by accident in the field of chance." The introduction of laryngoscopy was the turning point. It made the interior of the living larynx visible, and brought it within our reach. *Whereas before we saw not, now we see.* Making all due allowances for the greatest possible tact, ability and knowledge that can be acquired by a long experience with the aid of all *other* means of diagnosis except the laryngoscope, the difference between him who uses and him who does not use the instrument is, in many affections, the difference between him who endeavors to grope his way in the gloom of the darkest night, and him who walks securely under the light of the midday sun. By directly enlarging the field of topical therapeutics, by transferring laryngeal diseases from the domain of medicine to that of surgery, it has bestowed upon suffering humanity another and still greater boon. In this respect the benefits derived from its use leave far behind those of the stethoscope and ophthalmoscope; while with the stethoscope we may hear, and with the ophthalmoscope see, *what there is,* with the laryngoscope we not only see what there is, but can see *what we do* inside of the organ examined: we apply drugs, lance abscesses, cut out tumors in the interior of the larynx without the bloody laying open of the cavity from without; and while, before, the treatment of laryngeal diseases was generally unsuccessful, and always more or less guesswork, now there is no more satisfactory or grateful task in any branch of our art. And not only has the laryngoscope itself thrown a flood of light upon the larynx, but it has given such an impetus to the utilization of other means of diagnosis—to the prosecution of pathological anatomy, to the investigation of related organs in health and disease, and to the application of improved medicinal and operative measures—that laryngology has become a medical specialty, the exclusive pursuit of which completely fills a man's professional life.

But, gentlemen, instead of tracing before you the progress achieved during the past twenty-five years in either this or any other department of practice, I desire to bring to your attention some of those fundamental medico-philosophical questions which underlie all practice, and must occupy the reflective moods of every thoughtful physician. You will see that what at the time of our graduation constituted the most firmly established biological doctrines have since then undergone great change.

In 1857 it was regarded as a settled fact that all organized tissues are built up of morphological units, called cells; that is, that every plant and every animal is a cell or a congeries of cells. A cell was considered to be a minute vesicle or sac, enclosing, beside liquid contents of various character, a smaller vesicle, or a more or less solid mass, the nucleus, with sometimes a still smaller body, the nucleolus, and occasionally, even a still smaller one, the nucleolinus. The lowest organisms were supposed to consist of single cells, some of them devoid even of a nucleus; higher organisms were supposed to be made up of a number of cells, aggregating in the larger organisms to millions and millions. It was almost universally held, that though cells can, under favorable circumstances, arise spontaneously in a formless organic fluid, yet that no living being can spring directly from inorganic elements—so that minds were prepared for Virchow's doctrine

omnis cellula e cellulâ, *i. e.*, that cells can arise only from pre-existing cells. Furthermore, although in 1857 the correlation or essential unity of all force, as shown by the convertibility into each other of the various "modes of motion" observed by us as mechanical movement, heat, light and electricity, had already been proclaimed by a number of scientists, yet the facts and the consequences of this correlation were not generally known; and, although the "Vestiges of Creation"—an anonymous work showing great ingenuity, but only a moderate acquaintance with the facts of science—and other publications, both in America and Europe, had suggested doubts of the immutability of organic species, yet it was almost universally firmly believed that the various animals and plants existing on the earth are the essentially unchanged descendants of animals and plants created and endowed "in the beginning." The modification of these views can be, perhaps, best presented under the headings, Spontaneous Generation, Evolution and the Plastidule Hypothesis, Bioplasson.

I. SPONTANEOUS GENERATION.

Belief in spontaneous generation, *i. e.*, in the origination of living out of inorganic or non-living matter without the intervention of parents, is not by any means new. Having existed from ancient times, it has at various epochs been abandoned and again entertained. Three hundred years ago spontaneous generation was not only accepted as true but was held to be positively confirmed by the teachings of the Bible, and those who assailed it were accused of impiety and irreverence; while at the present day, on the contrary, many persons who object to it consider it to be contradicted by the Bible, and call its advocates irreligious and infidel. Indeed, whenever the result of scientific investigation has shocked contemporary religious belief, the investigators have been called bad names. When Copernicus published his book on the orbits of the celestial bodies, even Luther, the great reformer, said of him: "The fool wants to upset the whole science of astronomy, but, as Holy Scriptures show, Joshua commanded the sun to stand still, and not the earth." When Newton promulgated the greatest discovery ever made by man, namely, the law of gravity, Leibnitz attacked it as "subversive of natural and inferentially of revealed religion." But, gentlemen, the conflict between Science and Religion is rapidly drawing to a close. The people are becoming educated; and whatever any one at the present day may think of the Bible, it is clear that it cannot be regarded as a text-book of science, nor is it probable that it was ever intended to be so regarded. In any event, all attempts to bring the incontestable results of science into accord with the letter of the Bible by far-fetched interpretations and word-cavilings are ineffectual, ridiculous, and useless. God's truth is eternally the same. It cannot be inconsistent. It needs no excuse, and no reconciliation with human belief. It needs, on our part, thorough investigation, unprejudiced recognition, and courageous avowal. Although science may show any particular Biblical account, whether relating to cosmogony, to the age and primitive condition of man, to spontaneous generation, or to any other subject, to be erroneous, that does not in any way affect the moral truths and lessons which the Bible contains. On the contrary, the more the Bible is freed from its errors, the more brilliantly will its truths shine forth. Advances of science, whether consistent or inconsistent with existing religious opinions, never injure, but, on the contrary, promote the cause of religion and morals, of civilization and society.

The early naturalists thought that animals of even complex organization, such as maggots, worms, moths, eels, etc., could arise spontaneously. The modern view is so much different from this that perhaps the term "spontaneous generation," to which many object, is no longer applicable. At the present day it is admitted by all that every assemblage of organic phenomena must have had, as its immediate antecedent, some other assemblage of phenomena capable of giving rise to it. In the case of all organisms except the lowest it has been demonstrated that the only antecedent phenomena capable of giving rise to the organism in question is some other organism, but in the case of the lowest organisms, simple specks of living matter, it is contended by some that the requisite antecedent may, in some instances, be an assemblage of non-living materials. Hundreds and thousands of most carefully conducted experiments have been made to throw light upon the points in dispute. The true origin of maggots in putrefying flesh was shown by Redi, about three hundred years ago. He placed open-mouthed jars containing pieces of fresh meat in the sun, to putrefy; the mouths of some of the jars he closed with paper or gauze. Putrefaction occurred in all; but while there were maggots in the open jars, there were none in the closed. Maggots, however, were found on the paper or gauze, and it was ascertained that they were the progeny, in the larva state, of flies attracted by the odor of the putrefying flesh. When unable to reach the meat itself, they laid their eggs upon the covering of the jars, and out of their eggs the larvæ were developed. In other cases of supposed sponta-

neous generation, adequate investigation likewise showed the organisms to be produced by pre-existing parental organisms. This proved true in regard, for instance, to the sexless internal parasite, such as *cysticercus* and *trichina.* These creatures were found inhabiting the solid tissues of other animals, and furthermore, were seen to be incapable of exercising the function of generation. It was difficult, therefore, to account for their presence in the animal tissues unless by a growth upon the spot. But they were discovered to be the embryonic or youthful progeny of perfectly developed parents; the mode of their introduction into the internal cavities and tissues of the body was ascertained; and they were found to acquire, after a time, sexual organs, and to produce a new progeny by sexual generation.

It has been one of the earliest revelations of the microscope, that when a decaying organic substance is infused in water, myriads of minute living specks gradually appear in the infusion. Many persons regard these specks as *de novo* productions, while others ascribe their appearance to germs which pervade the atmosphere in countless numbers, and in nearly all places, which possess an almost indestructible tenacity of life, and are developed into active growth wherever they find a suitable nidus. Of the existence of germs there can be no doubt; they play an important rôle in the causation of infectious diseases. I need only allude to the investigations undertaken to determine whether the infusorial organisms are produced by the ingredients of the solution itself, or by germs derived from without. More than a hundred years ago, Needham prepared an infusion, thoroughly boiled it in a flask, corked it tight, sealed the cork with mastic, and covered the whole with hot ashes; designing to destroy by heat any germs which might be in the infusion, in the substance infused, or in the air above the liquid in the flask. After some days, or weeks, he found that, notwithstanding all these precautions, living organisms did make their appearance in the flask; precisely such as in freely exposed infusions habitually appeared earlier. This experiment was immediately repeated by Spallanzani, who, instead of corking his flask and cementing his corks, sealed the vessels by fusing the glass, and having thus completely cut off communication with the outward air, kept them at the boiling temperature for three-quarters of an hour, after which the infusion remained destitute of all forms of life. Such experiments, with various modifications and additional precautions, were tried by numerous observers, and they resulted triumphantly for the adherents to the doctrine of spontaneous generation and for its opponents, alternately; but, in spite of a few dissentients, about the time of the establishment of the cell doctrine—at all events, at the period of our graduation, twenty five years ago—the question was regarded among naturalists as *finally settled;* and settled adversely to the possibility of the non-parental origin of organisms.

In 1858 the controversy was revived, and prosecuted with more vigor than ever before. Pouchet took the ground that the former experiments in regard to boiled infusions were incorrect, and that, in point of fact, a preliminary boiling did not prevent the appearance of infusorial life. Pasteur, on the contrary, insisted that infusions hermetically sealed while boiling remained for indefinite periods of time free from all traces of organic life, while portions of the same infusions, exposed side by side with these, but open to the air, were speedily swarming with infusoriæ. He averred, further, that even an unsealed flask, of which the neck had been stopped during the boiling only with a plug of cotton, closely pressed together, or still more, a flask unsealed and without cotton, provided that the neck had been originally bent over, so as to direct the open mouth downward, continued free from the invasion of organisms; because in the one case the cotton would hold the germs, and because in the other the downward-bent neck would prevent their entering the flask, as they must necessarily subside into it from the air above. Both Pouchet and Pasteur have had, and still have, many followers. Hilgard investigated the infusorial circuit of generations. Wyman found that bacteria will make their appearance in infusions which have not only been boiled before being sealed up, but which, after being sealed, have been kept at a boiling heat for many hours, though these same organisms perish when exposed to a heat not over 134°F. Bastian, in a very extended series of experiments, has pushed the heat in the tubes containing his infusions as high as 300° F., maintaining this high temperature, in some instances, not less than four hours, and has yet found that living forms do not fail subsequently to make their appearance in them. Such forms appear also, he says, in solutions containing nothing of organic origin whatever, but which are composed of certain salts of soda and ammonia, and he even affirms that in such solutions he has occasionally seen very remarkable fungi present themselves, with their full fructification. On the other hand, Cohn has observed certain bodies in connection with bacteria which he considered as "quiescent spores;" that is, spores which do not immediately germinate, but may remain at rest for a long interval and afterwards become developed under other condi-

tions; and Billroth claims that although the vitality of bacteria is destroyed by boiling, their quiescent spores will withstand this temperature, are afterward capable of development into active forms, and may thus lead to the occasional appearance of microscopic life in organic solutions that have been subjected to ebullition.

The decision of the more general question of the origin of life on the earth does not depend upon the way in which this special controversy of the appearance of living organisms in such infusions is decided. There are the strongest grounds for believing that during a certain period no living beings existed, *or could exist*, upon this planet. The idea that they sprang from germs that came from some other planet is not now seriously entertained by anybody. The first living matter, to designate which we may well use the term *protoplasson*, must, therefore, have been produced out of lifeless matter. Now while it is true that the success of experiments, like some of those of Bastian, would furnish conclusive inductive proof of the conversion of inorganic elements into living matter, it is also true that their complete failure can in nowise be cited in evidence against the doctrine. The artificial production of living things, by giving us ocular testimony to the beginnings of life, would, no doubt, enlighten us considerably as to the physical and chemical conditions under which life originates; but the demonstrated impossibility of producing living things artificially would not weigh a feather in the scale against the doctrine that the conversion of inorganic not living into living matter may now occur, and at some time must have occurred, in the laboratory of nature. Indeed, no one who considers the subject seriously doubts that at some past time in the history of our globe such conversion has taken place, the difference among men being that some ascribe it to the exercise of direct creative agency in the case of each individual species, while others ascribe it in the first instance to the agency of properties inherent in matter and to "evolution into higher forms" subsequently; but, I repeat, the fact of such conversion must be admitted by every one, whether he be the most ultra free-thinker; whether he be the most literal interpreter of the Bible, which says of man, "And the Lord God formed man of the dust of the ground, and breathed into his nostrils the breath of life, and man became a living soul;" or whether he be anything between these two extremes. It is certain that if all the requisite conditions be present, the conversion of inorganic elements into living matter must necessarily take place. For my own part, I confess, that while I do not know what exactly these conditions are, and while I admit that human agency has never yet succeeded in bringing them demonstrably about, I see no difficulty in believing that they may occur in the great workshop of nature at any time—at the present time, as well as in a long past age; and that, *whenever they occur, to-day as well as in the remote past, the production of living protoplasson takes place.* *

II. EVOLUTION AND THE PLASTIDULE HYPOTHESIS.

The word evolution is used to designate the gradual modification from former condition which the existing universe and all that it contains has undergone. It is held to have been brought about, in the course of immeasurable time, by the operation of causes similar to those which are at work at the present day. The term development expresses the same idea, but is often restricted to the evolution of individual organic beings. Twenty-five years ago the belief was general that the world, especially the organic world, had been created in the condition in which we now see it; to-day hardly a single naturalist denies the truth of the general doctrine of evolution. The more clearly we appreciate the fact of the indestructibility of matter and the conservation of force, the more thoroughly must we accept its consequence in the process of evolution. If matter and force throughout the universe become neither more nor less, are neither new-created nor destroyed, all changes must be transmutations; the stock of material and energy being limited, each new effect must be at the expense of something preëxisting, and there must be a genetic relation between the present and the past in all parts of nature. In 1857, such views had certainly already been occasionally expressed. Lamarck had framed a distinct hypothesis of evolution half a century previously. He held that all organic forms, from the lowest to the highest, have been developed progressively from living microscopic particles. And, indeed, fifty years before Lamarck, Kant had announced his theory of the mechanical origin of the universe and of the relationship of all organisms to each other through generation from a common original germ. Some others had followed with similar notions, but it was only after the question was narrowed down to the mutability or immutability of species, and to the causes and extent of variation, as determined by observation and experiment, that the inquiry assumed a strictly scientific character. On July 1st, 1858, two essays were read before the Linnæan Society, in London, which became the impetus to the formulation and establishment of the evolution doctrine. One of these essays was by Charles Robert Darwin, and en-

* Where is the great workshop of Nature —
"Words, words, words"

titled "On the Tendency of Species to Form Varieties, and On the Perpetuation of Species and Varieties by Means of Natural Selection;" the other essay was by Alfred Russell Wallace, and was entitled "On the Tendency of Species to Depart Indefinitely from the Original Type." Wallace and Darwin had, independently, arrived at almost exactly the same general conclusions regarding the origin of organic species; Darwin, however, is entitled, not only to the credit of priority of investigation, but also to the honor of widely diffusing and establishing these conclusions by the publication, in 1859, of his epoch-making book, entitled "On the Origin of Species by Means of Natural Selection; or, the Preservation of Favored Races in the Struggle for Life." This whole volume is one long argument to prove the existence in nature, and the effectiveness, of a certain means of modification. It is primarily based upon well-known facts in the breeding of domestic animals and propagation of cultivated plants. The gardener, for example, who desires to produce a new form of a plant which is to be distinguished by the beautiful color of its flowers, will first of all make a selection from, perhaps, a great number of plants which are seedlings from one and the same parent; he will pick out those plants which exhibit most distinctly the color of flowers he desires. The color of flowers is a very variable thing, and plants which, as a rule, have a white flower, frequently show deviations into blue or red. Now, supposing the gardener wishes to obtain a red color in a plant usually producing white flowers; he will very carefully, from the many different individuals which are the descendants of one and the same seed plant, select those which most distinctly show a reddish tint, and sow them exclusively, in order to produce new individuals of the same kind. He will cast aside the seedlings showing a white or less distinct red color, and sow only the seeds produced by those whose blossoms show the red most markedly; from the seedlings of this second generation he will again carefully select those in which the red, which is now visible in the majority of them, is most distinctly displayed. If such a selection is carried on during a series of six or ten generations, and if the flower which shows the deepest red is carefully propagated, the gardener, in the sixth or tenth generation, will obtain the desired plant with flowers of a pure red.

The farmer, wishing to breed a special race of animals, for example, a kind of sheep distinguished by particularly fine wool, proceeds in a similar manner. He selects, with the greatest care and perseverance, from a whole flock of sheep, individuals with the finest wool; only these are used in breeding, and among their descendants those again are chosen which have the finest wool. If this careful selection is carried on through a series of generations, the selected breeding sheep are in the end distinguished by a wool which differs very strikingly from the wool of the original parent.

It is universally admitted that the modifications which may be thus produced are very profound. This is shown, for instance, in the numerous breeds of dogs which belong to the same species. Not only have they reached enormous differences in size (the largest being, according to Cuvier, 100 times larger than the smallest), but in muscular, bony, and nervous development, in form, strength, fleetness, and variety of instinct and intelligence. Domestic pigeons afford another example of the great plasticity of the living organism; for Naturalists believe that from a single species, the wild rock pigeon, there have arisen no fewer than 150 different kinds that breed true. And it can be proved of most of the domestic animals and cultivated plants, that all the different kinds are descendants of a single original wild species brought by man into a cultivated state.

The differences in the individuals that enter into consideration in artificial selection are sometimes extremely minute. The business of a breeder is not easy; it requires an exceedingly sharp eye, great patience, and very careful treatment of the organisms to be bred. In two succeeding generations even, the differences of individuals may be very insignificant, but by the accumulation of these minute differences during a series of generations, the deviation from the original form becomes, in the end, surprisingly great. The success of the breeder rests upon the two fundamental laws of the phenomena of all living beings, viz., the laws of variation or adaptation and of hereditary transmission. Adaptation or variation denotes all modifications which occur in the being from the moment of its production to that of its death; it is essentially the consequence of the influences which the organism experiences from its surroundings, or its conditions of existence. Hereditary transmission preserves in the progeny the constitution of the parental organisms as that constitution is at the time of the production of the progeny; it is essentially due to the continuity and partial identity of the producing and produced organisms. The breeder starts with the fact that all the individuals of one and the same species are different, even though in so very slight a degree as to be recognized by the practiced eye only. The shepherd, for example, by accurately observing their features, knows each of the individuals of his herd apart, while the uninitiated are incapable of distin-

guishing one sheep from another in the flock. In a forest consisting of only a single species of tree, you will certainly not find two trees alike in the form of their branches, or in the arrangement of their leaves, blossoms, and fruits. There are no two men perfectly equal in size, in form of face, etc. If it were not for individual differences, man's power of artificial breeding would be at an end. But individuality is a universal quality of all organisms, because surrounding circumstances, for instance, the many complicated conditions of nutrition, are never absolutely identical in two individuals of a species; and by influencing nutrition we are able to produce striking individual differences. After he has selected the individuals for propagation, the breeder avails himself of heredity to perpetuate and increase the characters he desires. An organism can transmit to its descendants not only those qualities of form, color, and size, which it has inherited from its parents, but it can also transmit changes of these qualities which it has acquired during its life, through climate, nourishment, training, etc. etc. The principle of breeding is exceedingly simple, but its practical application is in detail difficult and immensely complicated. A thoughtful breeder, acting according to a definite plan, must understand the art of correctly estimating, in every case, the interaction between heredity and mutability. This underlies his selection.

Now, the question was: Does there exist in nature a process which is the equivalent of human agency in breeding? Is there among wild animals and plants a tendency producing "natural selection?" Darwin discovered such a process and showed its results. The factor which in nature influences animals and plants, selecting and transforming them in a manner similar to the artificial selection practiced by the breeder, Darwin calls the "Struggle for Existence," while Hæckel describes it, perhaps more accurately, as "Competition for the means of Subsistence." Darwin says, in a letter, addressed to Hæckel, that, after his preparatory studies, the idea of natural selection flashed on him while reading Malthus' book "On the Conditions and the Consequences of the Increase of Population." It is proved, in that work, that the number of human beings, on the average, increases in a geometrical progression, while the amount of articles of food increases only in an arithmetrical progression. This disproportion gives rise to a number of inconveniences in the human community, which cause among men a continual competition to obtain the necessary means of life. Darwin applied the doctrine of Malthus to the whole animal and vegetable kingdoms. Every organism, from the commencement of its existence, has to struggle with a number of hostile influences; it struggles against other living beings which feed on it, against animals of prey and parasites; it struggles against inorganic influences of the most varied kind, against temperature, weather and other circumstances; and it also struggles against organisms most like and akin to itself. Every organism is endowed with enormous powers of increase, so that any one of the hundreds of thousands of species of plants or animals, if all its progeny were preserved, would go on multiplying until it filled the earth or covered the sea. Space is fixed, food limited, and the necessary consequence is competition for the indispensable supplies of life; multitudes perish, and comparatively few survive.

In the frequently recurring struggle for existence, any being that varies, however slightly, in any manner of advantage in the struggle, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be *naturally selected.* From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form. The strongest, the fleetest, the most cunning, in short, the best adapted to the condition around it, will live and multiply, while the less fit will disappear. At the present day no one denies that the "survival of the fittest," to use the phrase introduced by Herbert Spencer, really occurs, but the actual extent of the operation of natural selection remains yet to be determined. Darwin himself claims that it has been the main, though not the exclusive, means of modification. Darwinism is nothing more nor less than the theory of Natural Selection, but the term is frequently erroneously used as the equivalent of evolution, of which it is, however, but a minor part. Some persons even reject Darwinism, *i. e.*, the theory of Natural Selection, altogether, and nevertheless believe, to a greater or less extent, in evolution.

Indeed, as to the fact of evolution, there is hardly any dissentient voice; but as to the factors of evolution there is still need of thorough and individualizing investigation. Darwin has added Sexual Selection to Natural Selection as one of the means, and in one of the late editions of his work on the "Origin of Species," he says it has been effected chiefly through the natural selection of numerous successive, slight, favorable variations, aided in an important manner by the inherited effect of the use and disuse of parts, and in an unimportant manner, that is, in relation to adaptive structures, whether past or present, by the direct action of external conditions, and by variations

which seem to us, in our ignorance, to arise spontaneously.

Herbert Spencer has summed up his own theory in the following sixteen propositions:—

1. Throughout the universe, in general and in detail, there is an unceasing redistribution of matter and motion.

2. This redistribution constitutes evolution where there is a predominant integration of matter and dissipation of motion, and constitutes dissolution where there is a predominant absorption of motion and disintegration of matter.

3. Evolution is simple when the process of integration, or the formation of a coherent aggregate, proceeds uncomplicated by other processes.

4. Evolution is compound when, along with this primary change from an incoherent to a coherent state, there go on secondary changes due to differences in the circumstances of the different parts of the aggregate.

5. These secondary changes constitute a transformation of the homogeneous into the heterogeneous—a transformation which, like the first, is exhibited in the universe as a whole and in all (or nearly all) its details; in the aggregrate of stars and nebulæ; in the planetary system; in the earth as in an inorganic mass; in each organism, vegetal or animal; in the aggregrate of organisms throughout geologic time; in the mind; in society; in all products of social activity.

6. The process of integration, acting locally as well as generally, combines with that of differentiation to render this change not simply from homogeneity to heterogeneity, but from an indefinite homogeneity to a definite heterogeneity; and this trait of increasing definiteness, which accompanies the trait of increasing heterogeneity, is, like it, exhibited in the totality of things and in all its divisions and subdivisions down to the minutest.

7. Along with this redistribution of the matter composing any evolving aggregate, there goes on a redistribution of the retained motion of its components in relation to one another: this also becomes, step by step, more definitely heterogeneous.

8. In the absence of a homogeneity that is infinite and absolute, this redistribution, of which evolution is one phase, is inevitable. The causes which necessitate it are:—

9. The instability of the homogeneous; which is consequent upon the different exposures of the different parts of any limited aggregate to incidental forces.

10. The transformations hence resulting are complicated by the multiplication of effects; every mass and part of a mass on which a force falls subdivides and differentiates that force, which therefore proceeds to work a variety of changes; and each of these becomes the parent of similarly multiplying changes, the multiplication of these becoming greater in proportion as the aggregate becomes more heterogeneous.

11. These two causes of increasing differentiations are furthered by segregation, which is a process tending ever to separate unlike units and to bring together like units; so serving continually to sharpen, or make definite, differentiations otherwise caused.

12. Equilibration is the final result of these transformations which an evolving aggregate undergoes. The changes go on until there is reached an equilibrium between the forces which all parts of the aggregate are exposed to and the forces these parts oppose to them. Equilibration may pass through a transition stage of balanced motions (as in a planetary system), or of balanced functions (as in a living body), on to the ultimate equilibrium; but the state of rest in inorganic bodies, or death in organic bodies, is the necessary limit of the changes constituting evolution.

13. Dissolution is the counter change which sooner or later every evolved aggregate undergoes. Remaining exposed to surrounding forces that are unequilibrated, each aggregate is ever liable to be dissipated by the increase, gradual or sudden, of its contained motions; and its dissipation, quickly undergone by bodies lately animate, and slowly undergone by inanimate masses, remains to be undergone at an indefinitely remote period, by each planetary and stellar mass, which since an indefinitely remote period in the past has been slowly evolving, the cycle of its transformations being thus completed.

14. This rhythm of evolution and dissolution, completing itself during short periods in small aggregates, and in the vast aggregates distributed throughout space completing itself in periods which are immeasurable by human thought, is, as far as we can see, universal and eternal; each alternating phase of the process predominating now in this region of space and now in that, as local conditions determine.

15. All these phenomena, from their great features down to their minutest details, are necessary results of the persistence of force, under its forms of matter and motion. Given these in their known distributions through space, and their quantities being unchangeable either by increase or decrease, there inevitably result the continuous redistributions distinguishable as evolution and dissolution, as well as all those special traits above enumerated.

16. That which persists unchanging in quantity, but ever changing in form, under these

sensible appearances which the universe presents to us, transcends human knowledge and conception—is an unknown and unknowable power, which we are obliged to recognize as without limit in space, and without beginning or end in time."

In a contribution to the Doctrine of Evolution which I originally made in 1869, I endeavored to attain to a clearer understanding than had theretofore been had, of the phenomena of hereditary transmission. I asked myself the question: In what respect do the germs of the different individual organisms differ? Every one must admit that the germ from which a child proceeds consists of matter wholly derived from the bodies of its parents. In the same manner the germs from which these parents sprung existed in the bodies of their parents. Now, if we assume that some of the particles of matter from the grandparents have remained in the parental bodies until the procreation of the child, then there may be contained in the germ of the grandchild actual particles or molecules of living matter of the grandparents. To designate ultimate molecules of living matter, I use the term plastidules; and for those who can more readily conceive the idea of force being transmitted than matter, I may add that the term plastidule refers quite as much to a centre or bundle of force as to matter. Against the idea that plastidules of the grandparents would be present in the developed body of the parent, or that they would be preserved until the procreative act, the objection might be urged that the constant change of tissue in the body—decay, waste and excretion—would make the preservation of these particles of matter impossible. To such an objection the reply is, that the material of the body breaks down and is eliminated only through use, and that the use through which the particles under consideration are removed from the body is only the generative act, so that they may well be conserved until used for generation. Besides, it suffices to assume that the transmitted plastidules are not the identical ones of the grandparents, but molecules that have, by assimilative nutrition and growth, become, in all properties and capacities, like them, and for our argument may be, therefore, considered as such. Not only plastidules of the grandparents are assumed to be contained in the germ of the child, but also plastidules of the great-grandparents, and a long line of ancestors; and the difference between the germs of children of different parents consists in the fact that each contains the plastidules (molecules or bundles of force) of its own individual line of ancestors.

Now, let us suppose a primitive pair—Adam and Eve. Their children came from germs wholly derived from their bodies. The germs of the children of these children contained, mixed with the modified plastidules of their immediate progenitors, some of the plastidules of the first parental pair; and so on for succeeding generations. The further removed from the first ancestor, the smaller, of course, the quantity of the share in the constitution of the germ of the progeny. To express the idea arithmetically: in each succeeding generation, the numerator remaining the same, the denominator of the fraction of the set of plastidules from a particular ancestor increases.

Plastidules, though inconceivably small, nevertheless have actual dimensions, and it may well be conceived that after a certain vast number of generations the plastidules of a particular ancestor may exist very sparsely, or even not at all, in the germ of the progeny. This does not prevent, however, that the influence of these ancestral plastidules persists for a long time, since the plastidules of the succeeding ancestors still contain them, more or less mixed or modified. There may be circumstances, however, of which we are as yet ignorant, which may cause the exhaustion or diminution, or lessen the influence, of any particular plastidules, and these possibilities become a qualification of the proposition that the germ of every derivative living being contains plastidules of *all* its ancestors.

I have named this explanation of the phenomena of inheritance the hypothesis of regeneration, because, according to it, the ancestors are, to a certain extent, bodily, mentally, and in every other respect, born again in their progeny. It may be called, also, the hypothesis of the preservation of organic force, or of preservation of organic molecules, because, according to it, certain plastidules are, though not forever, for a long time preserved and transmitted from generation to generation. To designate the idea more simply, it is called the plastidule hypothesis. With the assumption of transmitted plastidules, the resemblances in features of children to grandparents, other inheritances from grandparents or still remoter ancestors, predispositions to disease, atavism, etc., are quite naturally explained.

The theory of evolution consonant with these views, connectedly, though very briefly, expressed, is as follows:—

All living beings have been originally produced by conversion of inorganic matter into the simplest organic being, protoplasson. This conversion, or (if you choose so to call it) "special creation," has been many times repeated since the beginning, and is still going on; and so has evolution, which is "regenera-

tion," according to the laws of adaptation and heredity, been going on from the beginning, and is still going on. The protoplasson which started upon its evolution first in time is, other circumstances being equal—*i.e.* possible chemical difference in different specks of primitive protoplasson, and different external conditions acting upon them, either to retard or accelerate evolution, or change its direction—most highly developed, which means that it may be stated as generally true, that the most highly developed organisms are so simply because they are the oldest in organic existence; those in their constitution nearest to protoplasson are the youngest.

The difference of rank among existing forms is mainly due to the difference of time during which, or the number of times which, regeneration has occurred; the difference of direction in which development has taken place is in part due to the modifying or adapting influences with which the organism has been surrounded; and the observed similarity between the series of rank among living animals and the series of geological succession is due to the greater or less resemblance of the influences to which organisms which originally were derived from more or less similar "protoplasson" have been throughout the ages past and are at present subjected.

Mr. Darwin states, as an inference from analogy, that "probably all the organic beings which have ever lived upon this earth have descended from some one primordial form." I believe that all living beings, other than the simple protoplasson, have, indeed, descended from one primordial form (viz. protoplasson), but from different individuals of such primordial form, which have originated at different times of the earth's existence, and have possibly, also, more or less differed in chemical constitution. Because ancestral plastidules exert their influence, the series of forms through which the individual organism passes in its development from germ to completed condition is a short repetition of the extended series of forms through which the ancestors of the same organism have passed from the oldest times to the present day. The reason why a fish, and not a chicken or a dog, grows out of the germ of a fish, is, that the germs of the different living beings existing at the present day having passed through stages of development that are different, are, in their constitution or mixture of plastidules, so completely dissimilar (just because each contains those of its own ancestry) that one organism can never be developed from the germ of another. But it must not be asserted that the fossil fish of the silurian age is the ancestor of any fish now living; on the contrary, if any of its progeny have survived, it probably belongs now to a different class of vertebrates; the fish of to-day comes from protoplasson which has originated later in time than that from which the silurian fish sprang.

Man has not been most recently created, but earliest! We are really the descendants, or ascendants, of the oldest inhabitant of our globe.

III. BIOPLASSON.

About the time of our graduation, the Cell Theory was believed to be true. In the course of the year 1858 Virchow promulgated his celebrated lectures on cellular pathology, which reached and deeply impressed the medical profession in every portion of the globe; in this it was maintained as a fact "that the cell is really the ultimate morphological element in which there is any manifestation of life, and that we must not transfer the seat of real action to any point beyond the cell." But at that very time investigations were on foot which proved that what was called a cell was not, in any proper sense of the word, a "cell" at all, that it was essentially a jelly-like mass of matter, characterized not by a membrane around, but by a nucleus within it; and further research showed that not even a nucleus is an essential constituent of what had been called a cell. In spite of the modification of the ideas associated with the word, the biological views dependent upon these ideas held their ground for many years longer; but at present biologists are compelled to ascribe the power of manifesting vital properties to "living matter," instead of restricting this power to any definite "form-element."

As long ago as in 1861, Brücke proposed to discontinue the use of the term "cell," as being a misnomer and misleading, and offered as a substitute "elementary organism." Beale proposed instead the word "bioplast," to designate any definite mass of living matter; and Hæckel the term "plastid." From the latter I devised the word "plastidule," as synonymous with ultimate molecule of living matter. Elementary living matter is called with Dujardin "sarcode," or with Von Mohl "protoplasm," or with Beale "bioplasm," or, still better (because it is a designation etymologically more nearly meaning living, forming matter), "bioplasson." Of these four synonymous terms "protoplasm" is the one best known; but has been used in other senses, as well as to designate merely elementary living matter; I therefore think that "bioplasson" is to be preferred. Of course, *dead* bioplasson is a contradiction in terms; bioplasson deprived of vitality is no longer bioplasson at all, but

merely the chemical remains of what *once was* bioplasson. If this be remembered, there will be no confusion, even if the word be used in describing tissues, etc., after death.

According to Drysdale, Dr. John Fletcher, of Edinburgh, was the first who clearly abandoned the idea that the material elements of an organism require the addition "of an immaterial or spiritual essence, substance, or power, general or local, whose presence is the efficient cause of life," and who arrived at the conclusion that "it is only in virtue of a specially living matter, universally diffused and intimately interwoven with its texture, that any tissue or part possesses vitality." He denied vitality to any gaseous or purely liquid fluid, and any hard or rigid solid; and thought the only truly living matter consisted "of the gray matter of the ganglionic nerves, which he held to be universally diffused, and the gray matter of the brain and spinal marrow." He described it as a "nitrogenous, pulpy, translucent, homogeneous matter, yielding, after death, fibrin." "Chemical analysis, accordingly, must be considered as useful in showing us, not what such matter *was composed of* while it possessed vitality, but what it is composed of *afterward*." "Not only is every vital action traced to molecular change, and to consumption and regeneration of this structureless, semi-fluid matter, combined in a way entirely *sui generis*, but the initiation of these changes is brought by Fletcher into absolute dependence on stimuli, and all spontaneity or autonomy is denied to matter in the living, just as in the dead state."

Drysdale further says: "If the grand theory of the one true living matter was, as we have seen, hypothetically advanced by Fletcher, yet the merit of the discovery of the actual anatomical representation of it belongs to Beale, in accordance with the usual and right award of the title of discoverer to him alone who demonstrates truths by proof and fact. * * * The cardinal point in the theory of Dr. Beale is not the destruction of the completeness of the cell of Schwann as the elementary unit, for that was already accomplished by others. * * * But that, from the earliest visible speck of germ, up to the last moment of life, in every living thing, plant, animal, and protist, the attribute of life is restricted to one anatomical element alone, and this homogeneous and structureless; while all the rest of the infinite variety of structure and composition, solid and fluid, which make up living things, is merely passive and lifeless formed material. This distinction into only two radically different kinds of matter, viz., the living or germinal matter and the formed or lifeless material, gives the *clue* whereby he clears up the confusion into which the cell-doctrine had fallen, and gives the point of departure for the theory of innate independent life of each part, which the cell-theory had aimed at, but failed to make good. The one true and only living matter—called by Beale germinal matter, or bioplasm—is described as 'always transparent and colorless, and as far as can be ascertained by examination with the highest powers, perfectly structureless; and it exhibits those same characters at every period of its existence." * * *

"The name of bioplasm," continues Drysdale, "given by Beale, or protoplasm, as indicating the ideal living matter, cannot be given to any substance displaying rigidity in any degree, nor to anything exhibiting a trace of structure to the finest microscope: nor to any liquid; nor to any substance capable of true solution. Thus, 'nothing that lives is alive in every part,' but as long as any individual part or tissue is properly called living it is only so in virtue of particles of the above-described protoplasm freely distributed among or interwoven with the textures so closely that there is scarcely any part $\frac{1}{500}$ of an inch in size but contains its portion of protoplasm. Thus we see realized the hypothesis of Fletcher, that all *living action* is performed *solely* by virtue of portions of irritable or living matter *interwoven* with the *otherwise dead* textures." The objection, however, urged by *Bastian* to Beale is so very pertinent, that it must also find a place here, but I shall not dwell upon other points on which Beale differs from the bioplasson doctrine; such as, that living matter exhibits the same characters at every period of its existence; and that it is always perfectly structureless. "It has always appeared to me," says Bastian, "to be a very fundamental objection to Beale's theory, that so many of the most characteristically vital phenomena of the higher animals should take place through the agency of tissues—muscle and nerve, for instance—by far the greater part of the bulk of which would, in accordance with Dr. Beale's view, have to be considered as *dead* and inert."

In 1873 the morphological knowledge of living matter became exact. In that year Heitzmann discovered the manner in which bioplasson is arranged throughout the body, and announced the fact that what had until then been regarded as *separate form-elements* in a tissue are really *interconnected portions* of living matter; that not only are there contained *no* isolated unit-masses in any *one* tissue, but *no tissue* in the *whole body* is isolated from the *other* tissues; and that the only unconnected particles of living matter are the corpuscular elements of liquids, such as blood, sperm, saliva, pus, etc., and so-called wandering corpuscles;

so that, to use his own words: "the animal body as a whole is a connected mass of protoplasma in which, in some part, are imbedded isolated protoplasma-corpuscles and various not-living substances (glue giving and mucin-containing substances in the widest sense, also fat, pigment-granules, etc.)."[1] This announcement marked the commencement of a new era in biology.

Heitzmann discovered that the living matter as seen in an amœba is *not without structure*, as had, before his accurate investigations, been supposed; and that its structure, in all cases when developed, is that of a network, in the meshes of which the bioplasson fluid, or the not-contractile, not-living portion of the organism exists. When there is a nucleus, it is connected by delicate threads with the extra-nuclear network; nucleoli and nucleolini inside of the nucleus, as well as granules outside, are portions of living matter; sometimes in lump, sometimes mere points of intersection of the threads constituting the intra-nuclear and extra-nuclear living networks, sometimes terminals of section of such threads, as first explained by Eimer, and after him by Klein.

Heitzmann discovered that what is true of the structure of bioplasson in the amœba, where a single small unit-mass of living matter constitutes the entire individual, is true also of the structure of bioplasson of all, even the highest, living organisms.

To be sure, much had been previously known regarding protoplasm or living matter, but the knowledge was fragmentary, until Heitzmann demonstrated *not only* that membrane, nucleus, nucleolus, granules, and threads *are really* the living contractile matter, but also, 1st, that this matter is arranged in a network, containing in its meshes the non-contractile matter, which is transformed into the various kinds of basis-substance, characterizing the different tissues of the body; and 2d, that the tissue-masses of bioplasson throughout the whole body are *interconnected* by means of fine threads of the *same* living matter.

Unless these two facts of Heitzmann's discovery are accepted, there cannot be urged much against the continued use of the word "cell," misnomer though it be. Ranke, after speaking of the "cell-wall," "cell-nucleus," etc., says: "of these component parts of the cell, one or other may be wanting without the totality ceasing to be a cell. The nucleoli, the cell-wall, or the nucleus may be wanting, and yet we must designate the microscopic form a cell, or elementary organism." Drysdale thus comments upon this quotation, viz.: "if any one choose to describe a gun-barrel as a stockless gun without a lock, he is free to do so; but what good purpose can it serve? Or is there even any fun in it? The truth is, this clinging to the mere name of the cell-theory by the Germans seems to arise from a kind of perverted idea of patriotism and of *pietas* toward Schwann and Schleiden." But I think Tyson has the better of the argument, in saying: "the word 'cell' has become so intimately associated with histology, that it is doubtful whether it will ever fall into disuse, nor does it much matter, so long as correct notions of the elementary part are obtained." Now, if *there were any* separate and distinct "elementary part," it certainly would matter little or nothing whether it were called "cell" or by any other name, provided the name be properly defined and agreed upon. It is not against the name, but against the idea of any *isolated, individualized form-element* that the objection lies. I have already said that in his lectures Virchow maintains "that the cell is really the ultimate morphological unit in which there is any manifestation of life, and that we must not transfer the seat of real action to any point beyond the cell." Against this statement nearly every author nowadays protests, and insists that the vital power must be transferred from the "cell to "living matter;" yet, after all, the disagreement, though ever so strenuously declared, is a mere verbal one, so long as both parties hold that "every higher animal presents itself as a sum of vital unities"—no matter what these unities are called or how defined. Hæckel, one of the most avowed advocates of "the protoplasm or sarcode theory," clings to Virchow's politico-physiological comparison, that every higher organism is like an organized social community or state, in which the individual citizens are represented by the "cells" (no matter how he may define these); each having a certain morphological and physiological autonomy, although on the other hand interdependent and subject to the laws of the whole. Heitzmann's views necessitate the comparison of the body to a machine, such as a watch or a steam engine, in which, though there are single parts, no part is at all autonomous, but all combine to make up one individual. Even Huxley, the popular champion of protoplasm as the physical basis of life, quite recently delivered an address, before the International Medical Congress, in London, August 9th, 1881, in which he used the following language: "in fact, the body is a machine of the nature of an army, not of that of a watch, or of a hydraulic apparatus. Of this army, each cell is a soldier," etc., etc. According to Hæckel and Huxley, the body is composed of *colonies* of amœbæ; according to Heitzmann the body *is one complex amœba.*

There is no better test of the truth of the bioplasson doctrine than the structure of hyaline cartilage. This has been looked upon, from the earliest time of histology to the present, as one of the simplest tissues. During the last two years I have made investigations which proved beyond the possibility of a doubt that instead of being a mass of basis substance in which a number of cartilage corpuscles are imbedded, hyaline cartilage is a filigree of living matter, in the meshes of which masses of basis substance are imbedded. This result of my observations admits of but one interpretation, and that an interpretation favorable to the bioplasson doctrine. To be able to uphold the cell-doctrine, cartilage would have to be, using a homely comparison, like a cake composed of hard dough with raisins. No matter how widely we may extend the definition, to remain within the boundary of that doctrine this metaphor must be applicable. Innumerable painstaking researches have led to various modifications of notions entertained regarding the structure of these two constituents and their relation to each other. It may be seen by the most recent publications on the subject, especially that of Flesch, that the acceptation of the existence in the dough of cleavage in certain directions of interlaminary and interfibrillar spaces, and of offshoots, even ramifying prolongations of the raisin-substance, or, at all events, of an ingredient of the raisins, is held to be not incompatible with that doctrine. If, however, we can represent cartilage as a filigree or framework of raisin substance, with here and there larger and smaller accumulations of this substance, in the meshes or interspaces of which framework blocks of dough are imbedded, certainly the fundamental view of the ultimate construction of the tissue is changed, and we are no longer in accord with the cell doctrine, even though we be inclined to use that term in the widest possible sense.

In regard to a name as a substitute for the term "cell," I would say that all corpuscular masses may be called simply corpuscles. For all the accumulations of living matter within the ordinary fields of basis substance, but more especially for those smaller masses which, having as yet developed neither a network structure nor much vacuolation, are still homogeneous, or nearly so, I am quite willing to adopt either the designation of "plastids," proposed by Hæckel, or that of "bioplasts," proposed by Beale. Perhaps it would be best to restrict the word "bioplast" to a small mass of living matter exhibiting no differentiation, and to distinguish from it as "plastid" the larger mass showing an interior structure more or less like the fully developed corpuscle. Thus, I would always use the term "plastid" in the place of "cell."

Perhaps I ought not to conclude without saying a few words as to the *practical* advantages of the Bioplasson Doctrine over the Cell Doctrine. Well, *every exact* scientific investigation, even though at first of *theoretical value* only, sooner or later brings with it some practical benefit; and this doctrine of living matter, aside from the satisfaction which the perception of ABSTRACT *truth* grants—lying as it does at the foundation of our knowledge of living things—has advanced their physiology and pathology at every point! In *Practical Medicine* it has already aided us in so many ways that their merest enumeration would require another hour's lecture. We know that the disposition of living matter is different in different persons, and that in the case of increased supply of food the *reaction* is different in strong and healthy people from that in the sick and weak. The *amount of living matter* within the same bulk *varies greatly*, both in normal and morbid conditions. A small lump of bioplasson in the urine or expectoration, taken from an individual of *good* constitution, will show a *close* network with coarse granulations, or perhaps be almost *homogeneous*-looking under the microscope—owing to the *large amount* of living matter in the small bulk; while a plastid from a weak, broken down or phthisical person will be finely granular and exhibit a *network with large meshes*, on account of the *relatively small amount of living matter* in it. Sometimes we thus, from the examination of a *drop of blood*, gain an insight into the condition and vital power of the whole individual; sometimes, recognize a disease before it is sufficiently developed to do much harm, and thus come a step nearer to the *highest aim* of the physician—the *prevention* as well as the cure of a disease.

My Young Alumni Brethren: Prof. Mitchell, in his charge, said to us: "The great desert of medical science, which a century ago displayed on its vast and unsettled plain of sand but a few bright spots of sustained verdure, now teems with the freshness of a thousand *oases*. Increasing rapidly in number, each growing broader and brighter, these spots of mingled certainty and promise are gradually concealing the dark waste of the bygone times, and are making our era as remarkable for the cultivation of the highest of the arts, as has been our country for the most brilliant transformation of the political principle." "Within or without strict professional limits, there is before you a rich harvest, ready for the sickle of enterprise, and the garner of industry and talent." "The work of honor and utility will proceed onward, urge it who may. Shall I not

hope, my estimable young friends, that among the laborers on this productive field of multifarious good, some, nay many of your number will be found conspicuous, in the very front of the enterprise?" Thus spoke Dr. Mitchell, in 1857.

What has been accomplished during the past twenty-five years has made the field more fruitful, and the rewards of investigation more sure; and may I not express a similar hope concerning you who have just joined our brotherhood? May the Alumni oration of 1907, at the time when you will celebrate your silver, and our class its golden wedding with the profession, delivered by one of your number, recount in glowing terms, among the greatest advances in medicine and biology the achievements of "Jeff" graduates of 1882.